THE

AËRONAUTICAL JOURNAL.

A QUARTERLY ILLUSTRATED MAGAZINE DEVOTED TO ALL SUBJECTS CONNECTED WITH THE NAVIGATION OF THE AIR.

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NOTICES OF The Aëronautical Society of Great Britain.

At a meeting of the Council of the Aëronautical Society of Great Britain, held at the Society of Arts, John Street, Adelphi, on Friday, December 15th, 1905, the following were elected members of the Society :—

Miss GERTRUDE BACON.
Mr. ALEXANDER KEITH.
Captain A. DE C. KING, R.E.
Mr. SAMUEL E. HITT.
Mr. FRANCIS CAMPBELL WESTLAND, R.E.

THE LIBRARY.

The following publications have been presented to the Library :—

By the Prussian Royal Meteorological Institute : "Ergebnisse der Arbeiten am Aëronautischen Observatorium," by R. ASSMANN and A. BERSON.

By Editor of *Knowledge and Scientific News* : "The Science Year Book," 1906.

By M. Wilfred de Fonvielle : "Impressions of an Aëronaut," by W. de Fonvielle.

GENERAL MEETING.

Amongst the papers to be read at the next General Meeting, the date of which will be duly announced, will be :—

"The Carrying Power of Aëroplanes," by Mr. JOSÉ WEISS (with practical demonstrations).

ERIC STUART BRUCE.
Honorary Secretary.

GENERAL MEETING.

The opening meeting of the Forty-first Session of the Aëronautical Society of Great Britain was held at the Society of Arts, John Street, Adelphi, on Friday, December 15th. The President, Major B. F. S. Baden-Powell was in the chair.

The Honorary Secretary (after reading the minutes of the last meeting), at the request of the British Commission of the Milan Exhibition, read the following letter from the International Committee for the Aëronautical competitions :—

It is desirable to call the attention of those interested in Division 8 of the Programme of the Section for Land Transportation to the importance which, in the case of a country like Great Britain, attaches to participation in the industrial side of the exhibition (light motors, tissues, appliances, gas plants, and various accessories), more especially in view of the impending developments of practical aëronautics, and of the new outlets that they promise to afford for special industries.

In respect to the competitions, it is a matter of congratulation that the number of participants from both foreign countries and Italy itself is very large, both for dirigibles, spherical balloons, and flying machines.

It is, therefore, desirable that Great Britain also should be represented in a way worthy of her reputation, and should not be withheld by undue exaggerations of a financial order.

To make the importance of the programme which has to be carried out thoroughly apparent, attention should be drawn to the £2,000 prize for dirigibles, and that of £400 for flying machines, without taking into account the other numerous prizes for kite trials, sounding balloons, and photographic trials which are of minor importance; the Committee will do all in its power to furnish gas of excellent quality gratis or at a nominal rate, important reductions on the ordinary tariffs will be obtained from the railways and shipping companies, free customs admission will be granted, and a bonus of 4 frs. per cubic metre to dirigibles in addition to transport bonus for competitions outside Milan, also the Committee will not fail to place at the disposal of competitors the labour required for handling, watching, and policing the extensive and elaborate installations in the Balloon Park. All this clearly shows the liberal scale on which the Committee is acting so as to do things in proportion with the increasing importance which the Exhibition is day by day assuming.

Many British subjects possess dirigible balloons, and interest is constantly being excited by their experiments in flying, and the Committee earnestly hopes that they may become competitors.

The Honorary Secretary announced that the programme of these Aëronautical Competitions would be as follows:—

Number.	NATURE OF THE COMPETITION.	PRIZES IN MONEY.		Date of Competition.	Total Amounts.
		1st Prize.	2nd Prize.		
		Lire.	Lire.		Lire.
1	Dirigible Airship competition	50000	..	from the 15th August to the 15th October.	74000
	(Besides the compensation at the rate of Lire 4 per cubic metre of the balloon for each competitor. Estimate 24,000 lire ..	..	..		
2	Competition for flying machines furnished with motor and carrying operator (Royal Prize)	10000	..	September	10000
3	Competition for flying machine models furnished with motors	2000	1000	,,	3000
4	Competition for aeroplanes without motor carrying operator	2000	1000	,,	3000
5	Competition for models of aeroplanes with mechanical start	800	400	,,	1200
6	Competition for kites for the exploration of the atmosphere	500	250	May and September	750
7	Competition for kites carrying operator destined to lift passengers and to be used for scientific purposes	1500	500	April and May	2000
8	Competition for sounding balloons	500	250	September	750
9	Photographic competition for photographs taken from balloons or kites for the purpose of topographical reliefs	300	100	from April to October	400
10	Photographic competition for photographs of meteorological phenomena	150	75	,,	225
				Carried forward	95325

Number.	NATURE OF THE COMPETITION.	PRIZES IN MONEY.		Date of Competition.	Total Amounts.
		1st Prize.	2nd Prize.		
		Lire.	Lire.		Lire.
				Brought forward	95325
11	Competition consisting in the passage of the Alpine zone from Milan to foreign countries for free balloons carrying people (date free)	1500	500	from 1st May to 30th September	2000
12	Competition consisting of staying above ground the longest time for free balloons carrying people (date free)	1000	500	,,	1500
13	Longest trip competition for free balloons carrying people (date free)	1000	500	,,	1500
14	Competition for balloons staying the longest time in the air carrying people and equipped, starting the same day (at a pre-established date)	700	300	April	1000
15	ditto	700	300	June	1000
16	ditto	700	300	September	1000
17	ditto	700	300	October	1000
18	Longest trip competition for free balloons carrying people and equipped, starting the same day (at a pre-established date) ..	700	300	May	1000
19	ditto	700	300	June	1000
20	ditto	700	300	October	1000
21	ditto	700	300	,,	1000
22	Minimum distance starting from a given point for free balloons carrying people (at a pre-established date)	500	250	April	750
23	ditto	500	250	May	750
24	ditto	500	250	June	750
25	ditto	500	250	,,	750
26	ditto	500	250	September	750
27	ditto	500	250	October	750
28	ditto	500	250	,,	750
				TOTAL	113575

SUPPLY OF GAS.

Illuminating gas for inflating balloons will be supplied as follows:—

Gratuitously to—

(*a*) all competitors starting in fixed date competitions.

(*b*) competitors starting in competitions with open date, which are classed in the first five on the winning list.

Other competitors will pay frs. 0.13 (1¼d.) per cubic metre (35 cub. ft.).

Gas will be supplied to all balloons making ascents without competing at the following rates:—

(*c*) fixed date ascents frs. 0.06 (½d.) per cubic metre.

(*d*) open date ascents frs. 0.13 (1¼d.) per cubic metre.

Competitors using hydrogen instead of lighting gas will be entitled to a bonus in cases *a* and *b* of frs. 0.13 (1¼d.) per cubic metre, and frs. 0.06 (½d.) in case *c*. (For other details see special forms of application.)

ENTRANCE FEES FOR COMPETITIONS.

Navigable Airship	200.00	lires.
Flying Machines—		
1. Those carrying operator ..	50	„
2. Unmanned ..	10	„
Kites—		
1. For scientific purposes	5	„
2. Man-lifting ..	10	„
Ballon-Sondes	5	„
Aërial Photographic Competitions	5	„

For the guidance of those who wish to take part in the various competitions, a series of pamphlets has been published by the Aëronautical Commission, descriptive of the rules for the various competitions, which can be obtained on application to the British Commission of the Milan Exhibition.

Members of the Aëronautical Society of Great Britain, and others, who may wish to take part in the above competitions or to acquire space for exhibits in the Aëronautical Section, are requested to communicate with Mr. Arthur Serena, Honorary Executive Commissioner for the British Commission, 1 & 2, Oxford Court, Cannon Street, London, E.C.

THE HONORARY SECRETARY: I need hardly point out that the prizes offered in these competitions are on a scale of unprecedented liberality. Few, I think, will have listened to the varied programme I have read without realising that the nations of the civilised world have determined that it is by united effort that the conquest of the air is to be achieved. All will join in congratulating the Italian nation in offering so powerful a stimulus to aërial experiment, research, and invention, as an International Tournament of the air.

In this country we are not without airships, ordinary free balloons, kites, and ballon-sondes. We have, too, photographers who have taken such distinct photographs at very great heights as to call forth the admiration of the world. There are, in fact, amongst the members of this society the representatives of every class of competition announced by the International Committee. If the proverbial winds of the British Isles have to some extent hindered experiments with mechanically-propelled airships, these very winds have been of late the means of conveying swiftly through the air ardent balloonists whose safe destination has been the other side of the Channel. We may, with reason, expect a large contingent of the balloonists of this country to take advantage of the many unpropelled balloon competitions.

The winds of this country are preeminently suited for the development of kites, which are really the basis of the motor-driven aëroplane. The International Kite Competition organised by this Society in 1903 showed that this country can boast of several types of kites, original in form and construction. Since that competition was held one of the kites that took part therein has been used by our own Government to lift men from the ground, with a view of supplementing the observation balloon in war. There will be no lack of opportunity for the kite flyers of the British Isles to win distinction in the kite competitions so excellently planned by the International Committee of the Milan Exhibition. (Applause.)

THE PRESIDENT: I do not think I need add many remarks to what has been said. We all hope to see some British representatives go out, and trust they will be successful. I understand Mr. Serena or his representative is here to-day, and, perhaps, he may say a few words.

In Mr. Serena's absence his SECRETARY

said: I am here representing Mr. Serena. I am his secretary, and I have a good deal to do with the organisation of the British section, and I have been asked to attend by your secretary in order to emphasise, I believe, the points that have been mentioned in that letter from the International Committee in connection with the Milan Exhibition. I can say that from many letters we have received, the Committee are anxiously impressing upon us that they look to Great Britain—they look largely to British representatives of ballooning and machines for flying in the air—to lead the way in these competitions. They say that they will be disappointed if they do not find them coming in great numbers. For that reason the British Commission have endeavoured to do all they can to bring the matter before this Society, and other Societies of the same kind, so that the wishes of the Italian Committee will be fulfilled that British scientists should be properly represented. The British Commission will do everything in their power to assist in every way possible towards the object in view; that is, to show the eminence of British pioneer work in this direction.

THE PRESIDENT: I do not think it will be necessary for me to introduce Miss Bacon, because everybody interested in aëronautics will know her name. They will know what a great assistance she was to her late father, and we all know what great interest he took in aëronautical subjects, particularly in scientific balloon investigation.

The Acoustical Experiments Carried out in Balloons by the late Rev. J. M. Bacon.

BY GERTRUDE BACON.*

The following is a statement of the results of certain acoustical investigations, in conducting which the late author was favoured by somewhat exceptional facilities. He writes: "In a long series of endeavours, during balloon travel, to aid in the investigation of the physical constitution of the upper air, I have constantly sought to determine variations, however trivial or transient, in the currents through which the balloon has had to climb. Results have been alike curious and instructive. Thus, a globe of thistle down will not sport in the air as it does above the hedge rows, but will take an independent course, often at variance with that of the balloon, striking off widely in an apparently chance direction, or, more curiously, mounting upwards past the balloon, even though this may be also ascending from discharge of ballast. Not infrequently when two similar light bodies are cast out in quick succession one will commence descending, while the other is swept upwards—actuated by some strong compulsion, so that they are shortly separated by a wide interval. Somewhat larger floating bodies, such as parachutes up to two feet in diameter, behave in a very similar manner, and though sailing more steadily, will almost always part company with the balloon, even though maintaining sensibly the same level; generally forging ahead.

This must be explained by the fact that any general air-stream is really made up of small impulsive streamlets, which, individually, may hurry on any light bodies which they entrap, but which, integrated over the large surface of a balloon, give to this a smaller net motion. A sheaf of loose leaflets thrown out in a bunch subside in leisurely fashion, and can be watched flashing in sunlight until they are several thousand feet below. They quickly separate, widening and lengthening out in extended order, and often closely resemble a flock of pigeons. They almost always wander away from the balloon's course, owing to their encountering diverse currents.

These diverse currents are most strikingly manifested by the descent of balls of crumpled paper. Falling more determinedly these will keep directly below the balloon till a cross current is reached, when they suddenly spin, and instantly dart away on a new course. Many tests have shown that diverse air streams commonly glide in juxtaposition one above the other, separated by a sharply defined plane of demarcation; and not only so, but an upper wind, holding persistently at the same level a fixed course, may apparently, at a definite point, separate into very distinct divergent courses, possibly in obedience to some influence due to the configuration of the country below. Starting on four consecutive days from West Ham, for example, the balloon was carried over the intervening seven miles direct to St. Paul's in a track

* The substance of this paper has been kindly compiled by Miss Bacon from notes of the paper the late Rev. J. M. Bacon had consented to read before the Society shortly before his lamented death. [ED.]

which remained as truly defined as is an ordinary highway, and so on to Hyde Park, where the straight course deviated, on some days taking the balloon to the south-west, towards Windsor Park, on others to the north-west over Buckinghamshire.

Lower down the air is in commotion with currents growing ever more complex and conflicting, until near earth it may be found being impelled in gusts from completely contrary quarters. This is very commonly so over the channel or river valley, and may be accounted for by supposing that in the case of an air current flowing up a channel the central part moves more rapidly than the sides, so that wind has a tendency to set from the sides towards mid-stream. At actual ground levels Professor Langley has shown that the complexity of the air currents is extreme, and that the wind, far from being a "mass of air in motion," really consists of small "waves and gushes," moving with irregularities of speed wholly unsuspected.

Everywhere, however, and at all heights ordinarily reached in balloon travel, the air streams are liable to be completely dominated locally by what are spoken of as vertical or chimney currents, but which are really slanting currents of wind ascending or descending. The play of these up and down draughts has already been shown as affecting light bodies of small size, but they often operate on a large scale. A down-rush of cold air extending over the whole area beneath a thunder cloud has, in personal experience, swept a balloon to earth in defiance of prodigal discharge of ballast. There is very commonly a copious down draught on the lee side of a hill, but the same is met with again in unexpected places over the country, just as at sea, when what sailors term a "singing wind" ruffles a particular patch of water on a calm day, betraying where a descending current, whose origin may be hard to divine, is impinging on an otherwise smooth surface.

Presuming that moist warm currents of air, rising promiscuously off diversified country, are a disturbing element, and the primary cause of so-called acoustic clouds, there appear to be two typical conditions of atmosphere affecting the transmission of sound: (1) Where ascending and compensating descending columns of air are in active progress, creating aërial chimney-shafts (as it were) blown aslant by the breeze, and (2) where there are layers of warmer or moister air already lying in definite strata at different heights; as, for instance, is commonly detected in ascents after nightfall. Acoustic conditions have been found to vary very much in the two cases.

In the first, sounds have comparatively small penetration along the ground, but occasionally reach to vast heights above. A band has been heard *momentarily* at 6,000 feet, and a street organ at 10,000 feet; not, however, vertically overhead, but to windward, suggesting that the avenues of sound lean with the wind.

In the second case sounds and echoes from earth heard from a balloon will remain obstinately muffled over a considerable area, and then for an interval become loud and clear. In this condition of atmosphere sounds across the surface of earth have been found far-reaching, and this possibly in consequence of reflection off the under surface of acoustic cloud layers. A homogeneous condition of air has always been found favourable to the penetration of sound. It may here also be noticed that an east wind levels the surface of any cloud with which it is in contact, and that sailors and coastguardsmen affirm that an east wind, though dry, aids sound, and in some cases they describe sound as then coming "high" or "from the sky."

Accepting these data it may now be possible to picture the appearance of a section of the atmosphere if made visible to the eye. It may be conceived somewhat to resemble, inversely, the flow of a deep and broad sweep of water, fed by side streams of various depths. The lowest stratum of air, like the uppermost layer of water, may be in strong commotion, tumbling hither and thither in waves and rushes, or forming into eddies. Higher in the atmosphere, as lower in the water, the disturbance is merely that of confluent streams asserting themselves in well defined and often far-reaching courses. Higher yet in air, as deep down in the water, the general onward sweep alone is manifested, and owing to the internal friction of air this upper sweep of air may have but little influence on the motions of that at lower levels. The nature of vertical currents may be sufficiently imagined by considering the familiar process of the formation of morning clouds on a summer day.

The operation of the air streams already considered may be traced in the travel of sounds which have sometimes appeared almost enigmatical, and which have been

investigated in experiments largely carried out by balloon. To take an example. At 10 p.m. on a night in June an ascent to an altitude of about 3,000 feet was made from the Crystal Palace with a moderate wind, which carried the balloon due east, and at certain irregular intervals a series of tonite service signals were fired below the car. The organised aid of some hundreds of observers had been enlisted, and as the times for firing had not been announced, the accuracy of the observations taken could be checked. The principal air currents were sufficiently tested by means of a number of addressed postcards thrown out in pairs, one weighted to fall rapidly to earth, its fellow attached to a parachute to fall leisurely. It was learnt that those dropped over Kent floated north, while those over Essex drifted south; that is, as in so many previous trials, the floating bodies from either shore sought the river, a fact which may be explained by supposing that, the air stream fairly following the river's bed, its central part would move more rapidly than the sides, so that the wind would have a tendency to set from the sides towards mid-stream.

Briefly summarising results it would appear that the range of audibility scarcely exceeded five miles, either up or down the wind in the balloon's path. On the other hand, the most complete series of reports were recorded by observers stationed at long distances athwart the wind, and, a very remarkable fact, such observers were generally found to be in groups, *i.e.*, within a mile or two of each other, as though the far aërial sounds were borne down to earth on favoured patches of ground here and there. At Brentwood, where the range of the nearest report would not be less than 10 miles, and of the furthest more than 20 miles, the complete series was heard by one observer. By another standing about a mile away six were heard out of eight, while at a rectory house in the same near locality the firing was actually heard within doors. At Sevenoaks, 14 miles south of the balloon's track, a correspondent records in accurate detail the reports, which he asserts "might have been heard from 10 miles beyond," a statement which is also supported by the evidence of a crop of other independent observers in the same immediate neighbourhood, who all heard the detonations with the same distinctness. Over a wide district outside this limited locality no sounds were recorded, but clustered round and about Edenbridge, three leagues further out, there were several listeners, while from Dormans, in Sussex, fully 20 miles away from the nearest firing point, come, curiously enough, the most complete record of all.

I cite this as a typical experiment closely in accord with numerous others, some of which have been carried out under the auspices of Trinity House, and others in concert with the military authorities. The way in which sounds reaching earth through the sky seem borne down, as described, on 'favourite patches," would appear to correspond and connect itself with the down draughts of air already described. Again the cases of inaudibility within sound range are reasonably attributable to invisible sound barriers of non-homogeneous air, of which an aërial observer notes frequent instances. On several occasions at an approximate height of from twelve hundred to fourteen hundred feet sounds from earth have, in a balloon descent, burst suddenly upon the ear, with an increase of distinctness altogether surprising. The effect of the intensity of sound, on coming within this particular limit, resembled the sudden augmenting of the noise of street traffic when a casement is raised.

Abundant and trustworthy evidence is to hand, alike from officers and men, of sounds at sea not heard by watchmen on look-out stations inshore or on cliffs, which sounds have, however, been distinctly heard a long distance inland and even behind rising ground. The cases in question seem to tally with the phenomena of "zones of inaudibility," reported on by American and other mariners. I submit that this same sound barrier, which would doubtless assume varieties of form, and which Tyndall conceived as bearing a close analogy to visible cloud, may, in part, account for the instances of greater range of sound across the wind. In aërial travel it is common to find banks of cloud which, when viewed from the level of their lower or upper margin, are seen to lie in a wave-like form, somewhat resembling the series of billows, or, rather, long rollers, of a wind-swept sea. Under these circumstances the view both ahead and astern, *i.e.*, in the line of the wind's course, is barred by the crests of the lofty surging cloud-waves, while right and left, or athwart the wind's course, but along the trough of the cloud-wave, vision becomes extended and absolutely clear. If, then, we may assume that visible cloud is the analogue of the acoustic cloud, we should

expect, under certain conditions of atmosphere, to find that sound, even though quickly quenched down the wind, might be heard at considerably greater ranges across the same wind.

It seems also beyond question that sounds heard at one level may be inaudible a few feet higher or lower. A man lost on the marshes at night and calling loudly for help has been unheard by the guard on the cliff, but a boatman a few feet below has heard him distinctly, and other similar instances might be cited. A sufficient explanation may be found here in the theory according to which a sound-wave, moving against the wind, is tilted upwards; but again the background (or shelter) of the listener must be taken into account as possibly lending extraordinary adventitious aid. Thus a gable end, or the hollow of a cliff maybe, has doubtless on occasion chanced to serve as a giant ear-trumpet.

Unquestionably we have to conceive the normal state of the atmosphere as of great complexity, and were the human eye so constituted as to be capable of regarding alike the myriad motions and mingling of air masses, we might discover not only a bewilderment of stream and eddy, such as we have briefly outlined, but that what we now deem the clearest sky is really flecked with forms far more varied and fantastic than any clouds which adorn our summer heavens.

THE PRESIDENT: The paper which has been read is one of very great interest indeed, and one that must be read through carefully to appreciate all it says.

COLONEL CUNNINGHAM: I can bear out what Miss Bacon has said about the irregularity of the motion of light particles let loose in a current of air. In water, in what is called a uniform current, the velocity of the different particles of water is really very different so far as can be evidenced by the motion of bodies thrown in at regular intervals. Thrown in at short intervals, they move very irregularly. With bodies so arranged as to be flowing with a large mass underneath, the same rule holds. Those sunk under the surface move in the same way, very irregularly. Although moving in the same line with a straight back, they move very variably. Some of the hinder ones will catch up the former ones. Some will diverge to the right, some will diverge to the left. And that is a strict analogy in water to the motion of particles in a free current of air.

MR. DINES: I might state that the late Sir Gabriel Stokes has stated that sound would be heard best across the wind. It is not true of sounds on the earth, for they are best heard down the wind, I believe.

MR. CODY: I quite agree with a clear atmosphere being caused by contraverse winds, because a kite will fly better in a moist atmosphere than in a dry one.

A vote of thanks was accorded to Miss Bacon for her interesting paper.

The Aëromobile.

BY C. F. WEBB.

This machine, called by its inventor the Aëromobile, is designed to accomplish gliding flight by the aid of propellers, to carry one man, and to manœuvre on or near the ground, before free flight is attempted, in order that its practicability may be thoroughly tested.

Theoretically, the fundamental principle upon which the practicability of the invention is based, is the determination by experiment of the exact relation existing between speed, supporting area, and weight, in order that, any two of the three being constant, the other may be varied in such a way that the result in a machine of this description shall always be equilibrium. Thus, to determine:—

(1) The speed necessary for a constant area to support a constant weight.

(2) The area necessary to support a constant weight at a constant speed.

(3) The weight that a constant area will support at a constant speed.

The construction is based upon two plain geometrical forms, viz.—

The triangle for balance;

The tetrabedron for structural strength, the two together giving stability, and is built on the modified lines of a soaring bird. The main point in which it differs from all other machines of its kind, is a peculiar form of aëro-supporting surface, which, by special adaptation, can vary its area in accordance with the requirements, in proportion, of the constants speed and weight, and automatically adapts itself to the requirements of the varying speed of the wind.

The machine is composed of four principal parts.

(1 & 2) The right and left aërocurve-supporting surfaces or wings.

(3) The rear aëroplane-supporting surface or tail.

(4) The car with ground wheels, propellers, motors, connecting frame, etc.

(1 & 2) The wings are right and left and situated on either side of the car, in such a way that the centre of support of each is some distance above the centre of mass of the machine. The principle of construction of each is the same, and is that of a fan curved from front to rear, with the outermost segment longer than the innermost, the other segments diminishing in length from the longer to the shorter arm. Each segment is free to slide over its neighbour, to which it is attached by a sliding tongue and groove joint, at the extremities, which prevent them from separating from each other and enable the wing to present a continuous surface to the air; they lap over each other when closing, and are held in position in regard to each other by V spring placed between each at the pivot, the total effect of these springs being to open the wing to its full spread. The segments are constructed of balloon fabric, varnished and stretched taut over the metal frames, each segment forming a small aërocurve surface in itself, and are manipulated by a Bowden wire lever, controlled from the car, which closes them by pulling against the counter-acting V springs at the pivot; they open automatically on being released. Besides the hand control there is also an automatic pendulum mechanism which regulates their area to the requirements of the wind, in any direction, when the hand gear is not in use. At the point of attachment of the wings to the car there is a kind of universal joint composed of two knuckle joints set at right angles to each other, which permits the short arm of the wing to move simultaneously with the long arm when the wing closes, and being provided with an extension spring allows the wing to give to pressure in an upward direction only.

The theory of construction is as follows:—Increase of speed or wind acting on an aërosupporting surface of fixed area increases the carrying capacity of that surface, thus upsetting equilibrium and rendering that surface beyond control. In this machine, therefore, the aërosupporting surfaces are so constructed that their carrying capacity is under the control of the operator at all times, by means of his ability to regulate their area to any conditions as they arise, *i.e.*, the requirements of speed and wind, viz.:—

In still air a certain area of supporting surface will be required to carry the machine at a certain speed, and if, for any reason (such as increase of speed or wind) the carrying capacity of that area is increased, a corresponding decrease in that area is necessary in order to restore control and equilibrium.

(3) The principle of construction of the tail or rear aëroplane is much the same as that of the wings. It consists of two fans opening automatically and closing by means of Bowden wire levers, on a centre-fixed segment which is jointed to the rear end of the triangular frame by a knuckle joint which allows it to move in an upward direction, this movement being restrained by an extension spring. Its purpose is primarily to preserve balance, and it is set at a slight angle to the horizontal plane, as it also supports some portion of the total weight.

The total area of all the aërosupporting surfaces is so arranged that the area presented to the air shall be slightly greater in extent than that required to support the machine at its lowest speed.

(4) The car consists of a triangular frame of bamboo coming together at the end at which it joints with the tail and clamped round the circumference of the conical shell containing the mechanism at the other end. This conical shell is made of thin sheet metal rivetted over, channel, and T metal rings and girders, and forms the principal part of the machine. It contains the motors and liquid air reservoirs, and the controlling mechanism of the aërosupporting surfaces. To it are bolted the ground wheels and the wings and propellers. On the bottom bar of the bamboo frame, close behind the conical shell or cab, is fixed the driver's saddle or seat, and directly underneath is a small pneumatic wheel, which can move round laterally, and which, in conjunction with two larger wheels on either side of the conical shell, serve to support the machine while on the ground, and, being set on springs, assist it to alight on to and take off from the ground without undue jar to the machine or its occupant. Below the operator's seat and affixed to the rim of the cab are two foot rests.

The motive power is supplied by two turbines driven by compressed air transformed from liquid air carried in two reservoirs during flight, and are situated one on either

side of the transformer and controlled by Bowden wire levers. From the turbines a shaft runs out to the gear box at the end of the propeller bracket, which drives the propellers.

The propellers are set on either side of the car at the apex of a pyramidal bracket formed of three bamboo struts, so that they drive on a plane, passing through the centre of mass of the machine, which is situated low down, and are very broad in proportion to their length. By a special compensating arrangement of the air cocks admitting air to the turbines, they can be reciprocally controlled, *i.e.*, either can be increased or decreased in speed as much as the other is decreased or increased in speed respectively; they thus serve to drive the machine to right and left, and constitute the guiding as well as driving mechanism. They drive at right angles to the driving shaft by a bevel pinion gear in the gear box, and are made of balloon fabric stretched over metal frames and varnished.

The end of the conical shell facing the operator is open; at the apex of the cone is a cap which can be opened, thus enabling the operator to get at all parts of the machinery.

SUMMARY.

The whole machine is made of the lightest possible materials, compatible with the requisite strength (probably the various alloys of aluminium), and is set on springs and roller or ball bearings wherever possible in order to obtain a minimum of friction with a maximum of elasticity, having regard to the elastic nature of the medium in which the machine is designed to manœuvre. All levers will work on the principle of the Bowden wire lever as far as possible. The relations of the parts to one another can be seen by referring to the plans.

HOW THE EVOLUTIONS ARE PERFORMED.

(1) When driving horizontally to rise from one level to another: Increase slightly and simultaneously the area of the wings and the speed.

(2) To descend from one level to another: Decrease slightly and simultaneously wing area and the speed.

(3) To turn to the right: Increase the speed of the left propeller and decrease the speed of the right by the compensating gear.

Any combination of these evolutions can be made, and while they are being made the automatic mechanism controlling the aërosupporting surfaces is thrown out of gear. While in gear its action is as follows:—

When travelling horizontally:—(1) For a head wind: The effect of a head wind is to tip the machine fore and aft. This tilting brings into action a pendulum which opens an air cock and permits air to act on a piston, to which the wires controlling the wing area are attached, thus exerting a pull on the wires and decreasing the total area until equilibrium is restored (2) For a beam wind: The effect of a beam wind is to produce a list from port to starboard or *vice versâ*. This listing brings into action another pendulum, which permits air to act on the piston to which the wire controlling the wing on the side from which the wind is coming is fixed, and decreasing it in area. (3) For a rear wind: The effect of a rear wind is to increase the speed of the machine, but since it will be travelling on air already in motion, no decrease of area will be necessary.

Any combination of these actions can take place.

Other wind currents, such as wind from below or above, must be dealt with as experiment shall determine.

NEW INVENTIONS EMBODIED IN THIS MACHINE.

(1) Aërosupporting surfaces having a variable area, the supporting capacity of which can be altered at the will of the operator.

(2) The combination of aërocurve and aëroplane surfaces.

(3) The application of the turbine to aërial navigation.

(4) The application of liquid air to the turbine in the form of compressed air.

(5) The compensating reciprocal action of the propellors.

(6) The automatic pendulum mechanism controlling the area of the aërosupporting surfaces.

(7) The shape and relation of the parts of the machine to one another.

Several drawings descriptive of the parts of the Aëromobile were exhibited to the meeting.

THE PRESIDENT: This paper is what one might call rather an elaborate one, considering that it is not apparently describing any machine which has been actually made and tried, but, rather, a design for one which has not been tested in any way. It is extremely difficult to give any kind of opinion as to how such a machine would behave, and it may, perhaps, therefore, be rather unnecessary to consider such details as the author goes into until the matter has been tested. However, as far as one can judge, the apparatus is fairly soundly devised. The author ends up by claiming certain new inventions. I do not know to what extent they may be described as new, but I think most of the ideas he here suggests have been suggested before, I might almost say, by the members of this Society. I understand that Mr. Webb's brother is here, and if so, perhaps he may throw a little more light on the subject.

MR. CODY: I would ask Mr. Webb whether the man who made the machine has considered what weight the machine would be, and whether he has tested the spread that he has in the machine lifting that weight.

MR. WEBB: My brother has not formed any idea of what the surface would be or the weight of the machine.

MR. CODY: I do not want to be a sceptic, but I am now becoming very interested in the dynamics of flying machines, and the sooner, I think, that our colleagues commence to build their machines lighter and larger, the sooner we shall have a machine that will fly. It seems as though many men build their shape on paper, and if they think they know how to maintain that shape with the wind on it, it is more than I can see. So I ask if the man has spread his sail for the purpose of lifting any weight. At the last meeting, in July, I stated I was building a gliding machine, and I have now built it, and I am surprised at its success. It has 807 feet of surface, and weighs 116 lbs. It carried 8 or 10 men up the second day we had it out—all separately, naturally, for it was only made to carry one man at a time. I have many pupils who are willing to work in any kind of machine I care to make, because I carry out the idea of having sufficient sail surface to parachute them to the ground in safety. I have photographs of the machine flying in the air, being carried, and packed up by three men. (Photographs shown.)

MR. REID: I should like to ask as to the application of liquid air. If you enclose liquid air, you must have a vessel of enormous strength, and this would be prohibitive, because you could not carry such a vessel with a balloon. You are bound to have an explosion unless you carry it in a very powerful vessel.

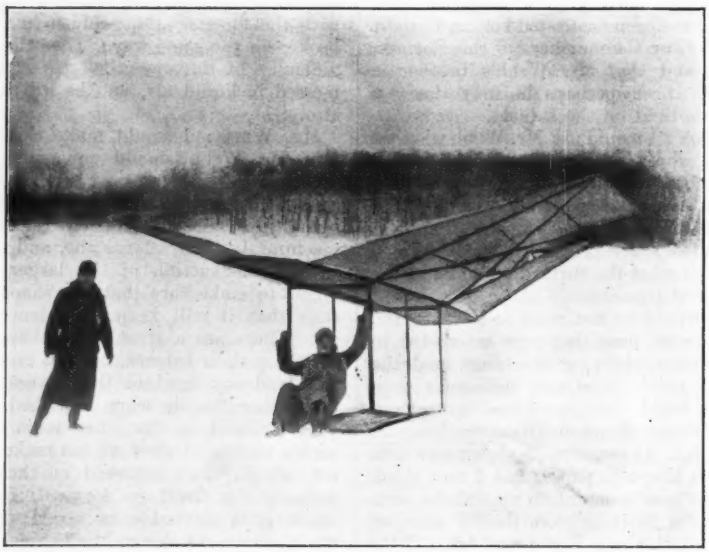
COLONEL CUNNINGHAM: I do not know if there has ever been a successful use of liquid air. There are great difficulties in the way. Among them is the intense cold. Everything in the neighbourhood of the expanding air will be frozen. The liquid oil will be frozen. Then the metal materials which come in contact with the expanding liquid air will be rendered brittle. Lead, for instance, a ductile material, becomes, when dipped in liquid air, capable of being broken with the fingers. India-rubber can also be broken in the same way. Then there is the difficulty of the operator. He will be immersed in liquid air, and he will be frozen also.

MR. WEISS: I would make this remark, that Mr. Webb should construct a small model of the machine, and try if it flies, because all those who have tried to make aëroplanes must know it is easier to make a small machine fly than a large one, and therefore before construction of the larger one, he ought to make sure that the shape of it is such that it will keep its balance in the air. There are a great many shapes which will keep their balance, but not every shape will, and any machine that is not capable of holding the air when launched without a motor, will not fly when it is launched with a motor. Unless we can make a machine, which, when launched on the air will actually by itself go forward, I do not think it is advisable to spend time and brain power to devise mechanical means. With birds the main factor of the motive power is the weight. The best proof of this is that many men have with aëroplanes weighing up to 30 lbs., obtained glides with a drop of only 1 in 15. But the main factor of flight is a very correct weighting, a very correct centre of gravity, and other features which are absolutely necessary in order to obtain eventually a working flying machine. The Hon. Secretary has asked me if I could prepare a paper to give some particulars about some experiments I have made, and I shall be glad to do so at some future opportunity, when I shall be able to come with figures, and, perhaps, show you what the correct weight is, and what correct placing of the centre of gravity can do with regard to flying. There is one thing I may

mention: When I was lately in France I had to spend a number of days amongst the islands on the Seine, and I noticed the flight of the herons there. I have always believed that one of the main factors of flight was the facility with which the birds could shift their centre of gravity at a moment's notice, as we shift our balance in guiding a bicycle. With those birds it was most noticeable. These birds have very long necks, and in a lateral flight their necks are in the shape of an S. You can very plainly detect the shifting of the centre of gravity with the head. I have come to the certainty that it is so. I noticed when a bird was flying leisurely, the S was perfect; when against the wind it was only half an S; and sometimes when a bird passed near me flying leisurely, I clapped my hands, and the bird's neck shot clean out in a moment, so quickly did it shift its centre of gravity. It is a fact that as soon as you increase your speed, you must shift your centre of gravity forward.

Colonel Capper: I should like to make one remark with reference to the number of new things that were claimed for this machine. I regret to find there is a tendency among inventors to claim something novel, and I think a rush for patents for every little thing has a tendency to cramp the perfection of these machines. If gentlemen who do not hope to make anything commercially out of the machines would be willing to put their information at the disposal of the general public, we should get on faster.

Mr. Webb: I do not think my brother made any experiments with the liquid air, but he has made models of the shape of the machine he describes, and has found them to keep their balance. He found they fell at a very low rate, and would glide over a large surface before they came to the ground.



TOBOGGAN GLIDER AT MONTREAL.

The Chairman: I think all we can do is to propose a vote of thanks to the author of this paper. He has taken a great deal of trouble to work up this subject, and has spent a great deal of time in inventing a great many ingenious contrivances, which may possibly be of value later on when the machine has taken a more definite form. (Carried unanimously.)

Notes by Colonial and American Correspondents.

1.—TOBOGGAN GLIDER EXPERIMENTS.

By H. J. Hitchcock.

2.—AN ALUMINIUM AIRSHIP.

By H. J. Hitchcock.

3.—A NEW METHOD OF EXPERIMENTING WITH GLIDING FLIGHTS.

By A. A. Merrill.

We have received the following notes by Colonial and American correspondents:—Mr. H. J. Hitchcock, of Montreal, Canada, sends us photographs, plans, and particulars of a Toboggan glider with which he made experiments in the vicinity of the Park Slide at Montreal. Mr. Hitchcock states that he was stimulated to try these experiments by the accounts of our President's glider canoe at the Crystal Palace in 1904, which was described in the journal of this Society. I am sure we are all interested to know that our President's experiments have been instigating other minds in distant countries, and to see photographs of the type of machine that is the outcome of his work. Mr. Hitchcock states that the weight of the glider was 150 lbs.

It had an area of lifting surface of 235 square feet. The best lift from the ground was about a foot. This was owing to the difficulty of getting a steep enough hill.

Mr. Hitchcock thought the Society would be also interesting to see photographs of Mr. Filion's aluminium airship tried at Montreal in the summer of 1904. It was, he says, always kept captive, and could only lift small boys. Pure hydrogen was used.

The following note on a new method of experimenting with gliding flights has been contributed by Mr. A. A. Merrill, of Boston, U.S.A.

The signal success in gliding flight obtained by the Wright Bros. should teach us all that their method is the one to be copied. They are now thoroughly proficient in the art of gliding, and in this respect are far in advance of all other workers. Personally I believe that, regardless of the type of machine used, the guiding of it will have to be learned by each individual by many trials at simple gliding flight.

Although one of the first to use a glider in America, circumstances prevented me from getting results at all comparable with Chanute's, not to speak of Wright's. For the last two years, not having the chance of testing a full-sized machine, I have spent considerable thought upon the best methods of gliding, and wish now to put before the members of the Aëronautical Society of Great Britain my plan.

In the middle of a large field free from trees and rocks, with a sandy soil if possible, a hole should be dug about 25 to 30 feet deep and, say, 8 feet in diameter. Over this hole a large sheave pulley on a steel shaft is placed, and above the pulley is a swivel pulley. (Diagram shown.) Attached to the shaft is a strong rope with a heavy weight at its lower end in the hole, and attached to the pulley is a wire or small cord. By pulling out the cord the weight is raised, thus storing energy, which can be used to raise the glider by attaching the cord to it, in the same way that a boy would raise a kite by running with the string. A trip hook allows the cord to be released at any time by the operator, and a band brake on the pulley will check the fall of the weight when the cord is released. The swivel pulley allows a flight to start from any part of the field, so that advantage may be taken of a wind in any direction. Flights may be made in a calm or in any wind with the use of this apparatus, and provided care is taken that the cord is strong enough not to break under the strain, and that the trip hook is working properly, there should be no danger. At St. Louis a winding apparatus driven by electricity was used with success, but, owing to the carelessness of the operator, a cord which had been frayed was used, and this broke at a time when the operator was not ready to descend. The fall caused an injured ankle, which was not serious, and the fall was seventy feet.

The falling weight has an advantage over the motor-driven machine in that it is cheaper and costs less to handle.

I want to urge upon all the readers of this magazine the necessity of practising the art of gliding. Go on with your plans of a power machine if you wish, but meanwhile learn to glide. The above plan is a good one for practising glides, and as the glider can be disconnected at any height, there should be no danger.

THE PRESIDENT: It is not mentioned in Mr. Hitchcock's paper that an aluminium balloon was made in Germany about 1898. I understand that Mr. Merrill's idea is to sink a pit in order to have a weight to run down. It seems an elaborate way of proceeding. A simpler method would be to run up a pole or mast.

MR. CODY: I must say that I believe in gliding, but I believe in not going to anything but the level ground to do it, and making the glider lift you as a kite. When you are ready to glide, find out by slacking the cable, and if you can glide, you will do so; if not, you will come to the earth. You can tilt your machine in any position you desire. By these photos you will see what spread I deem necessary for gliding. I am 204 lbs. in weight, and my machine weighs 116 pounds.

You will draw your own conclusion from the spread, and you will see that the spread is pretty well level. I only count half a lift for a slanting surface. 807 square feet of lifting surface are required to carry 320 lbs., and I succeeded in getting up many other men of varied weights. I do not hold that a machine need have a certain spread for a certain weight. If that is necessary, then it would be useless in warfare. The wind necessary to lift me with that machine is 600 feet a minute by the anemometer. I have never found two anemometers record alike, although made by the same maker and from the same model, so I go by one purchased from a London firm, and I work with that only. I found that my anemometer measured 600 feet a minute when the glider lifted me. If it measured 450 feet it would lift my son, who weighs 11 stone. Sometimes we sent it up with 50 lbs. of sand, and it seemed to lift with the same difficulty that it lifted me. Our longest glide was 740 feet with a drop of 350 feet, carrying 1 lb. to the 3 square feet. This was officially recorded by more than one person, and the glides were repeated regularly. The machine would glide forward, thrown up as a kite; in fact, it may be called a kite. My longest glide was 80 yards with the wind. It went down into the valley and up again over some telegraph wires, and landed right side up. It is absolutely impossible for it to turn over, no matter what the currents of wind are.

COLONEL CAPPER: I should like to say a word about this machine, which I have seen. It is a very pretty machine, indeed, and most ingenious. It flies as a kite flies in the lightest of wind, and seemed extraordinarily safe, and if you can get a machine that is safe, that is the first thing. That way of putting a man up a short distance in the air and letting the machine loose to glide to the ground has many merits. It is a very quick method. If you read the records of the Wright Brothers, you find they had to wait for a wind blowing in the right direction, and in the first four years of their work they only glided a very few minutes. On a captive kite there is a certain amount of experience, and a large number of men can be put up a short distance very quickly.

COLONEL CUNNINGHAM: I would like to ask what was the section of the sustaining surface of your kite. Was it a circle?

MR. CODY: It was flat. It has a little turn down in front, but I would not recommend anyone else to try that. The best place to learn to fly is on London Bridge. There is nothing better than the sea gull to learn your flight from. You will learn more by standing on London Bridge and watching the sea gull than by spending £6,000 in machinery. I have enquired as to permission for catching these birds and weighing and measuring them, and I have been granted that permission if I go at a certain time. There is, in my opinion, no curve down in the front part of the sea gull's wing. It is almost flat, and the quickness of the changing flight is marvellous. I reckon it at 30 miles an hour.

MR. KEITH: I mentioned at the last meeting that in the wing of a bird there are two muscles, one of which curves the wing downwards, while the other raises the front, so that when it goes down it curves downwards, and when it comes up it is almost flat.

Recent Experiments of the Brothers Wright.

Mr. Alexander then read the following letter from the Wright Brothers, dated November 17, 1905:—

"We have finished our experiments for this year after a season of gratifying success. Our field of experiment, which is situated eight miles east of Dayton, has been very unfavourable for experiment a great part of the time, owing to the nature of the soil, and the frequent rains of the past summer. Up to September 6 we had the machine on but eight different days,

testing a number of changes which we had made since 1904, and as a result the flights on these days were not so long as our ones of last year. During the month of September we gradually improved in our practice, and on the 26th made a flight of a little over 11 miles. On the 30th we increased this to twelve and one-fifth miles, on October 3 to fifteen and one-third miles, on October 4 to twenty and three-fourth miles, and on the 5th to twenty-four and one-fourth miles. All of these flights were made at about thirty-eight miles an hour, the flight of the 5th occupying thirty minutes three seconds. Landings were caused by the exhaustion of the supply of fuel in the flights of September 26, and 30, and October 8, and in those of October 3 and 4 by the heating of bearings in the transmission of which oil cups had never been fitted. But before the flight on October 5 oil cups had been fitted to all the bearings, and the small gasolene can had been replaced with one that carried enough fuel for an hour's flight. Unfortunately, we neglected to refill the reservoir just before starting, and as a result the flight was limited to 38 minutes. We had intended to place the record above the hour, but the attention these flights were beginning to attract compelled us to suddenly discontinue our experiments in order to prevent the construction of the machine from becoming public.

"The machine passed through all of these flights without the slightest damage. In each of these flights we returned frequently to the starting point, passing high over heads of the spectators.

ORVILLE WRIGHT."

THE PRESIDENT: I think that sounds like a remarkable statement. We have not heard much of what the Brothers Wright have been doing recently. We heard a year or two ago that they had made some successful flights, but this sounds a very successful result. I shall certainly be longing to hear more of the details of these flights. To remain half an hour in the air seems extraordinary.

A vote of thanks having been accorded to the President, the proceedings then terminated.

The Dines Meteorograph.

Conspicuous amongst the objects of aëronautical interest on exhibition at the above meeting was the meteorograph for use with kites, designed by Mr. Dines and kindly lent by Mr. J. J. Hicks. The instrument contains barograph, hygrograph, and thermograph, and combines strength, lightness, simplicity, and cheapness. The costliness of meteorographs in the past has done much to limit kite meteorological observations. This obstacle to progress has been removed by Mr. Dines, the meteorograph and the kite that carries it together costing between two and three pounds. The weight of the instrument is only $1\frac{3}{4}$ lbs. For a full description of the working parts of this instrument the reader is referred to the description in the Journal of the Royal Meteorological Society, July, 1905.

A New Continuous Motor.

Another exhibit at the above meeting was a model of the Continuous Impulse Petrol Motor specially designed for the propulsion of flying machines by Mr. W. Cochrane.

The following particulars have been supplied by the inventor:—

The new type of motor consists of a central double-ended cylinder and two single-ended cylinders, the three cylinders being arranged tandem fashion. Trunk pistons work in the single-ended cylinders, while a double-acting piston works in the central cylinder. One of the trunk pistons drives on to a crank shaft and all the pistons are made to work in synchronism by cross-pins passing through the pistons and through slots in the cylinder walls, and tied together by yoke rods. The pistons are fitted with packing rings and are long enough to prevent over-running of the slots, which would cause leakage. They are allowed to travel right to the end of the cylinders, compression being allowed for by making the ends of the pistons concave as shown in dotted lines. The body of the engine is made in two castings placed end to end. These are water jacketted, the water being admitted for this purpose. The central piston is also water cooled, the water for this purpose being conducted through one of the hollow cross-pins, and leaving by the other end, and flexible pipes being fastened to the end of this pin.

As regards the valves, they are of the ordinary type and arranged horizontally,

although they may be vertical as in an ordinary petrol motor. The admission valves are all disposed on one side of the motor, whilst the exhaust valves are all on the other side. They are worked by cams from a horizontal lay shaft driven by spiral gear wheels, as usual, from the crank shaft. Lubrication is effected from the top of the cylinders.

From the above brief description it will be understood that the engine is very compact. It will also be noticed (since it works on a four-stroke cycle) that the shock of the explosion is taken up through the yoke rods by the compression which is simultaneously occurring in one of the other cylinders.

A motor for a flying machine constructed on this system could be made very light and compact, and would work with a very light fly-wheel.

If desired, the cylinders might be arranged in pairs side by side. They would work two cranks 90° apart; this would represent an 8-cylinder engine.

There is no central piston rod or stuffing boxes and glands, and it would be very difficult to get out of order.

If desired the engine would work compactly in a vertical plane by arranging two double-acting cylinders side by side; they would work two cranks 90° apart; this would represent in practice a four-cylinder engine; the arrangement is applicable to steam engines. A form of rotary valve gear has been designed, having a disc or plug operated without springs by pawl levers working in slots on the inside of the yoke rods.

Applications for Patents.

(*Made in October, November, and December, 1905.*)

The following list of Applications for Patents connected with Aëronautics has been specially compiled for the AËRONAUTICAL JOURNAL by Messrs. BROMHEAD & Co., Patent Agents, 33, Cannon Street, London, E.C.

OCTOBER.

19789. September 30th. CHARLES JAMES BELLAMY. **An improved Apparatus for steering Air-ships.**

20097. October 4th. WILLIAM EVANS. **Improvements in revolving Aërial machines for recreation or amusement.**

20930. October 16th. CECIL FRANCIS WEBB. **An improved self-supporting Aëroplane.**

21894. October 27th. HENRY LOVE. **Improvements in Aërial Machines.**

22026. October 28th. LOUIS ERNST. **Improvements in and relating to Machines for Aërial navigation.** Henry Alonzo Buck, of France.

NOVEMBER.

22650. November 6th. THOMAS HURST and JOHN COLLINS. **An improved Captive Flying Machine.**

23235. November 11th. REGINALD MANSFIELD BALSTON. **Improvements in or relating to Kites and similar apparatus for Aërial flight.**

24285. November 24th. WILLIAM HOUSTON. **Carrier Screws for ships, boats and the like, also for Aërial vessels.**

24704. November 29th. WILLIAM HENRY DOBSON. **Improvements in jet-propellors for propelling sea-going vessels, and for raising, supporting, and propelling Aërial Vessels.**

DECEMBER.

25395. December 6th. FREDERICK RICHARD SIMMS. **Improvements in or connected with Flying Machines.**